Super-Slab®

Precast Pavement

Installation Manual

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August 18, 2015

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Introduction

The Super-Slab®* System was developed by The Fort Miller Co., Inc. in 1999 as a method of installing high performance precast slabs directly on grade to provide the pavement industry a rapid repair technique for use on heavily traveled highways. Since the first project in 2001, over 2,000,000 SF of precast slabs have been successfully installed during off-peak hours with minimal impact on the traveling public. This total equates to over 33 lane-miles of highway, 85% of which is servicing over 100,000 vehicles per day.

The slab-on-grade System described in this Manual is comprised of precisely-fabricated three-dimensional precast slabs, methods of precision grading and a unique method of structurally interlocking slabs together to create a long-lasting, permanent pavement structure. The System mobilizes ordinary construction materials, equipment and labor to accomplish "out-of-the-ordinary" overnight replacement of concrete pavement.

This Manual provides step-by-step descriptions of pavement sawing, installation of dowel bars, fine grading, surveying, slab installation and grouting techniques that are specific and vital to the Super-Slab® System. While most of these are variations of operations common in the construction industry, the super-grading process is unique in that it is more exacting than current fine grading practices. The reader is advised that successful installation of Super-Slab® is contingent upon strict adherence to the techniques described herein and that the use of alternate unproven methods is not recommended.

The Super-Slab System is "new" to the construction industry. The technology described in this Manual is still under development and refinements are expected to be made as the system evolves. This Manual, therefore, should be considered a living document that will be upgraded and revised periodically as owners, designers and contractors expand their use of the Super-Slab® System.

Super-Slab® is a patented product protected under at least one of US Patent numbers 6,607,329 B2; 6,663,315, 6,709,192, 6,899,489, 6,962,462, 7,004,674 and 7,467,776B2, Canadian Patent numbers 2,413,610, 2,525,264 and other U.S. and foreign patents pending. Super-Slab® is a registered US Trademark owned by The Fort Miller Co. Inc.

Chapter 1
The Basics of the Super-Slab® System

1. General

Successful installation of Super-Slab® is dependent upon a thorough understanding of the product and the process used to install it. The Super-Slab® System consists of precisely fabricated precast slabs, methods of installation and materials for interlocking them together to create an integrated pavement structure. The System is comprised of the following:

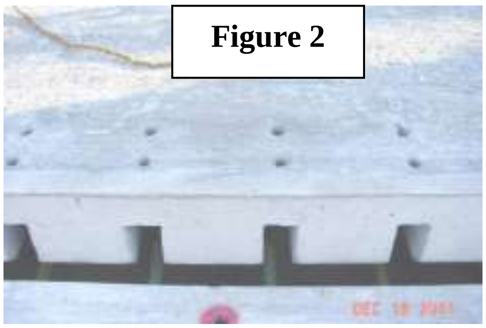
1. Constant thickness precast slabs that are fabricated to length, width and thickness as required to a tolerance of ± 3 mm (+/- 1/8").
2. Techniques for precision grading to a similar tolerance.
3. Interlocking dowels, tie bars and matching slots cast into the bottom of adjacent slabs.
4. Installation of non-shrink structural grout into the slots
5. Positively filling voids under the slabs (should they exist) by pumping bedding grout into them by means of a bedding grout distribution system cast into the bottom of each slab

2. Precast Slabs

Slabs are fabricated with high performance concrete manufactured under controlled conditions in precast facilities approved by The Fort Miller Co., Inc. The facility's quality control plan, quality control personnel, manufacturing and storage capabilities are evaluated prior to approval. Fort Miller provides training in form set-up, casting, finishing, foam gasket installation, storage, and shipment to the job site.

Slabs are manufactured in accordance with pre-approved shop drawings and mark numbered for identification purposes. The fabrication tolerances are very tight to ensure slabs fit together in the field and that they conform to the precision grade prepared for them. Dowels, tie bars, matching inverted dovetail slots and lifting inserts are cast in the slab as seen in **Figure 1** enabling individually-placed slabs to be interlocked together and function as an integrated pavement structure.

Figure 1



Slab interlock is achieved by placing each slab over the dowels protruding from the previously-set slab as seen in **Figure 2**. The interlock is completed by pumping non-shrink structural grout through port holes, also visible in **Figure 2.**

The arrangement of dovetail slots cast on the bottom of the slab provides the following benefits:

a. The structural grout on the bottom of the slab is protected from damaging de-icing chemicals
b. The surface of the pavement is more uniform and attractive in appearance because the dowel grout is out of sight
c. The dovetail shape of the slots enhances the structural capacity of the connection by providing mechanical resistance to dowel bar pop-out, a common problem that has been encountered with conventional dowel bar retrofit.

2. Slab Sizes

While all slabs are cast to a uniform thickness specific to every job, lengths, widths and plan-view shapes may vary to meet geometric requirements. Rectangular shapes are appropriate for straight roadways while trapezoidal-shaped slabs may be required for ramps or intersections.

Slabs are typically cast in 12' (nominal) widths as required for design lane widths. Slabs are also cast in other widths (both smaller and larger) as may be required, for example in a toll plaza to match smaller toll booth lane widths.

It is desirable to keep slab widths constant, if possible, to keep fabrication costs to a minimum. This is usually possible on projects where all of the slabs are being replaced. Where slabs are installed intermittently (patching) in interior lanes it is necessary to measure the distance between existing longitudinal joints and to fabricate the slabs accordingly. In such cases the slab must be "custom cast" to a unique width for each location.

Slabs are cast in lengths varying from 6’ to 18’, depending upon the nature of the project. On intermittent repair projects slabs are typically cast in standard 6’ to 14’ lengths, in increments of 2’. Each repair area is replaced by selecting a size (or a multiple of sizes) from this “menu” of standard lengths. On continuous repair projects the slab length is typically optimized so that a load of slabs approaches 48,000 pounds, to keep freight costs to a minimum.

3. Slab Geometry

Before any slabs are fabricated it is necessary to determine exact slab geometry. A detailed slab layout drawing is developed to show the plan view location of every slab **(Figure 3)**. This drawing aids in calculating “x”, “y”, “z” values of every corner of every slab. These values are used in slab fabrication and in the fine grading operation as will be discussed in Chapter 4. The plan view shape and size of each slab is defined by specific “x” and “y” coordinate values. Similarly, vertical geometry is defined by the “z” coordinate values of the corners of each slab.

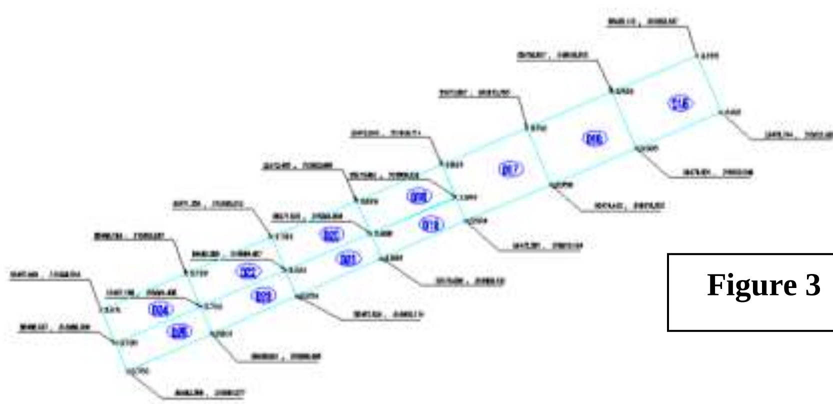


Figure 3

When the “z” values of all four corners reside in the same plane it is defined as a **single plane** slab. Single plane slabs are used for “continuous replacement” on portions of the highway where the cross slope remains constant. They are also commonly used for small areas such as “patches” and joint replacements for “intermittent” repair projects.

When it can be established ahead of time that all slabs are single plane the calculation of three dimensional coordinates is not required. A slab layout drawing or a table of slab locations is recommended for fabrication and layout purposes.

When the “z” value of one corner of a slab is out of the plane established by the other three corners it is called a **warped plane slab** as shown in **Figure 3-A.** The cross slope of a warped slab varies linearly from one end of the slab to the other. Warped slabs are required in areas of a highway where super-elevation changes (as horizontal alignment changes), on curved ramps or at intersections where the cross slope and profile of one highway blends into the cross slope and profile of the intersecting highway.

Figure 3-A

4. Precision Grading

A key element of the Super-Slab® System is the precisely graded subgrade surface that minimizes, if not eliminates, vertical adjustment of slabs after they have been placed. The subgrade is graded to the same “x”, “y”, “z” values to which the slabs are cast, ensuring they “match” vertically, as well as horizontally, within the allowable tolerances. While this is a simple concept it demands a surface accuracy that is more exacting than that commonly required for cast-in-place pavements.

5. The Bedding Grout Distribution System

The intent of providing a precise subgrade surface is to provide full and complete support to the new slabs such that they are grade-supported. Since it is difficult to fabricate perfect slabs and a perfectly matching subgrade surface, a unique bedding grout distribution system (visible in **Figure 4**) is built into each slab to aid in the installation of void filling grout to ensure complete and full bedding of every slab. It is comprised of a series of half-round channels cast in the bottom of the slab (that extend from one end of the slab to the other) bounded and separated by foam gaskets (black in the photo) attached to the bottom of the slab.

Figure 4

After all of the slabs have been placed and the slots are filled with structural grout, non-structural bedding grout is pumped through a port at one end of each channel until it exudes from a port at the other end of the same channel. Because of the high fluidity of the grout, it will percolate beneath the slab, positively filling any voids in the chamber bounded by the pre-attached foam gaskets.

Chapter 2

Removal of Existing Pavement

1. General

Before the removal operation begins the existing concrete pavement is cut to the proper limits and into sizes appropriate for handling. Advance saw cutting should be scheduled so the length of time sawed pavement is open to traffic without load transfer dowels is minimized. Sawed pavement sections tend to "move" under dynamic loading, increasing the possibility of rapid development of faulting at the saw cuts.

Longitudinal joints of multiple lane pavements are sawed to cut existing tie bars and/or keyways. A longitudinal cut should also be made in the adjacent asphalt shoulder, a few inches away from the edge of the pavement, to prevent breakage of shoulder pavement when the existing pavement is removed.

2. Saw Cutting the First and the Last Transverse Joints (Continuous Installations)

The first transverse cut is made at the beginning limit of the precast slab installation. The transverse cut made at the end limit must be laid out and made with care to ensure the new slab, or series of slabs, fits in the resulting space with enough room left over for specified transverse joint widths. The distance between the beginning and ending transverse joints is

$$D \text{ (Hole Opening)} = (N)\ TL + (N+1)\ JW/2$$

Where "D" is the hole opening or the total distance from the beginning saw cut to the end saw cut, "N" is the number of slabs, "TL" is the theoretical (design) length of the slab, and "JW" is the design finished joint width. The actual length of any slab is the theoretical length of the slab plus or minus the allowable fabrication tolerance.

When only a portion of the slabs in a continuous stretch of new slabs can be installed in any given night the hole should be cut large enough to accommodate the dowels protruding from the last slab that is placed. Provision should be made to protect the dowels before the slabs are opened to traffic. The best way to do this is to install a short re-usable 3' terminus slab (specially fabricated for this purpose) that has been fabricated with slots along one end only. The hole cut in the existing pavement must be large enough to accommodate the terminus slab.

3. Saw Cutting for Intermittent Repair

Saw cuts made for "drop-in" slabs must be made accurately to ensure the "hole" fits the prefabricated slab. This is accomplished by using a steel template that is fabricated **to the exact required dimensions for each slab and its corresponding transverse joints.** Such a template, shown in **Figure 5**, is laid over the distressed area and adjusted square to the longitudinal joint. The light demolition saw shown in the photo is used to score the pavement along the template to preserve the mark for subsequent full depth cutting.

To stay within the maximum allowable joint width (1/2" in most states) transverse cuts must be made with care to the lines established with the template. It has been shown on previous Super-Slab® projects that if properly sized templates are used, and the saw operator carefully follows the marks, the above-referenced tolerance can be met.

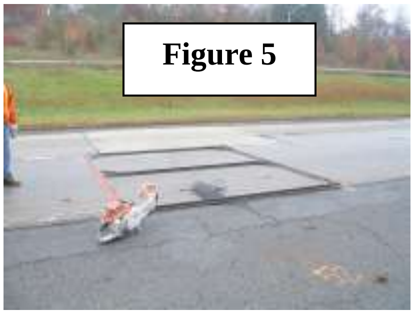


Figure 5

As with continuous replacement, longitudinal cuts should be made in the shoulder adjacent to the areas to be removed.

4. Managing Expansion of Existing Pavement During Construction

It should be pointed out that as temperatures rise during the day the pavement expands creating compressive stresses in the pavement that make saw cutting and pavement removal difficult. One way these stresses may be relieved is to cut four or six inch wide transverse slots (such as that made with a Vermeer type saw) in the existing pavement prior to removal of any existing concrete. Backfilling the slots with asphalt allows the pavement to absorb the stresses making cutting and removal easier. The slots should be installed at 500' to 1000' intervals depending upon the anticipated temperature rise and the condition of the existing pavement.

5. Pavement Removal

The existing pavement is removed by either the "lift out method" or by using conventional excavator techniques.

The "lift out removal method" is accomplished by lifting out pieces with a light crane or an excavator. Lift cables are attached to wedge-type picking eyes **(Figure 6)** that are driven into pre-drilled holes in each piece or to other types of lift anchors. The main advantage of this method is that it minimizes disturbance and consequential repair of the existing subgrade surface.

Figure 6

Figure 7

While the excavator removal method **(Figure 7)** may appear to be faster than the lift out method, it inherently results in a disturbed subgrade surface that must be re-graded and re-compacted. Repair of a disturbed subgrade surface takes extra time and bedding material and should be avoided if at all possible to make the most of short overnight work windows. In cases where the existing pavement is asphalt or broken up concrete, there is no choice but to use this method.

Care should be taken to prevent spalling or chipping of the existing pavement that is to remain in place. In the lift out method spalls are frequently made when the slab being removed is wedged in place. Spalling also occurs in the excavator method if the slab being removed is "crowded" against the existing concrete that is to remain. Spalling of the existing pavement to remain only makes more work that can be avoided if care is exercised during removal.

For continuous runs of pavement, most contractors use a "slab-crab" type bucket for removal of existing pavement, which can be very fast and allows removal of large pieces of pavement easily and rapidly.

Chapter 3

Drilling and Anchoring Dowels

1. General:

When new Super-Slabs are placed next to each other dowels and tie bars are cast in each slab to match inverted slots cast in the adjacent slab. When new slabs are placed next to existing pavement, slots are cast in the new slab to allow it to be placed over new dowels or tie bars that are field-anchored into the existing slab. It is important that the dowels and tie bars be anchored in the correct location in order for the new slabs to fit.

For a continuous replacement, dowels are installed only at the beginning and the end of the run, since intermediate slabs are shipped with dowels already cast in. If the new Super-Slabs are installed next to existing concrete that is to remain, most states require tie bars to be installed along the longitudinal joints.

For intermittent repairs, especially for single slab installations, transverse dowels are installed for almost every slab. Dowel installation becomes a major and vital part of the overnight operation and it is important to choose the right equipment and procedure to achieve the required accuracy and to maximize the production rate.

2. Dowel and Tie Bar Layout

Dowels and tie bars that are field anchored need to be laid out accurately to ensure they match up correctly with the corresponding inverted slots cast in the new slab. They should be laid out exactly as shown **on the approved slab layout drawing or the approved shop drawings,** whichever is appropriate. The layout should be done by a surveyor or other qualified individual who is trained in proper measurement techniques. When laying out tie bars for continuous replacement projects keep in mind each slab will be placed at theoretical locations shown **on the approved layout drawing.**

Dowels for single slabs are easily marked out by using a template as shown in **Figure 8**. The template must be
laid out accurately and set at the proper starting point each time it is used.

Figure 8

3. Drilling for Dowels (Intermittent Repair)

For maximum efficiency, dowels should be drilled immediately after the old concrete has been removed and before the subgrade is graded. Epoxy anchoring of the dowels should be delayed until after the subgrade has been compacted and graded.

If the drill hits reinforcing steel in the existing concrete while drilling, it is hard to keep it at the exact marked-out location. Since the location of the dowels cannot be changed **it is advisable to use a drill that is heavy enough to keep the bit in the proper location until it punches through the steel.**

The manual single bit drill shown in **Figure 9** drills one hole at a time. Because it is relatively light it is easily dislocated if the bit hits steel. A backhoe-mounted drill, such as that shown in **Figure 10**, is faster and heavy enough to punch through most steel encountered in the existing pavement.

Figure 9

Figure 10

For optimum production use a gang drill with the appropriate number of bits. If four dowels are required in each wheel path, for example, use a gang drill that is equipped with four bits to minimize the number of times the drill has to be carefully lined up to the layout marks. **It typically takes longer to line up the drill than it does to drill the holes. A lot of time can be saved if lining-up-time is minimized.** Care must also be taken to level the drill prior to drilling to insure the dowels are installed parallel to the roadway surface and square to the transverse joint.

It is advisable to consult with competent drill suppliers when selecting the drill type and size. If an air driven drill is used, keep in mind the sizes of the compressor, hoses and fittings are just as important as the drill size, as the performance of the former is entirely dependent upon the latter.

4. Anchoring Dowels and Tie Bars

Use the anchoring material (epoxy) in strict accordance with the manufacturer’s direction. After the hole is blown out with air and the interior wire brushed, place epoxy in each hole as required so the entire dowel is surrounded with epoxy to ensure that it acts properly as a load transfer device. It is advisable to install the epoxy material with pneumatic or battery-powered applicators; hand-powered caulking guns just cannot squeeze out the epoxy effectively. The air compressor that is used to blow out the dowel holes can also be used to power the applicators. This should be a separate compressor from the unit that powers the dowel drill rig so that the drilling operation can proceed independently from other operations along the critical path. Be sure and twist the dowel a minimum of three full rotations to insure full contact with the epoxy and the sides of the hole. Round plastic epoxy-retention discs should also be used to keep the epoxy from running out of the hole before it sets.

Some states and provinces allow the use of Ambex cementitious grout sausages for anchoring dowels and tie bars. Holes should still be drilled and cleaned with care, although they may remain damp. The proper drill size, and sausage size (diameter and length), must be chosen carefully according to the manufacturer’s directions. Sausages must be soaked in water for 1-2 minutes, or until the bubbles stop coming out. The end with the staple should be twisted off and the sausage inserted into the hole. Then the dowel or tie bar should be inserted, hammered home, but not twisted into place, as this will shear the thixotropic grout.

Chapter 4

Precision Grading (Supergrading)

1. General

Most highway contractors are experienced in building a fine grade surface (for cast-in-place pavement concrete) such as that specified by NY State DOT as a "fine grade surface that is at true grade and surface at any location, $\pm$ 6 mm".

The fine grade surface required for Super-Slab® is defined as a precisely graded subgrade surface that is "theoretically" accurate to a tolerance of $\pm$ 3 mm (1/8") and parallel to the pavement surface.

The difference in tolerance of the two fine grades described above is profound and the latter requires equipment and methods not well known to the industry. This chapter describes the technology required to achieve such surfaces.

2. Some Definitions

For the purposes of this Manual the precision grading process required to achieve an accurate surface is called "super-grading" and the completed surface is called a "super-grade".

Super-grading is defined as a grading process achieved by using specialized laser or otherwise mechanically controlled grading devices to achieve a three dimensional subgrade surface that is theoretically correct to within a tolerance of $\pm$ 3 mm. (+/- 1/8")

A **super-grade** is defined as a fully compacted subgrade surface that is parallel to the finished pavement surface and is theoretically correct to within a tolerance of $\pm$ 3 mm (+/- 1/8")

3. The Importance and Advantages of Super-grading

The benefits of providing a super-grade are as follows:

a. A precisely graded surface provides "complete and uniform" (within the tolerances indicated above) support to newly-placed precast slabs. This "nearly complete" support allows newly-placed slabs to be opened to traffic before they are fully grouted. This is a huge advantage in maximizing the use of brief overnight work windows.

b. The precise surface uniformly engages gaskets on the bottom of the slabs ensuring leak-free and positive grout filling of any voids (if any exist) during the bedding grout installation process.

c. A precise surface minimizes the amount of bedding grout required and the time required to install it.

d. Providing a precisely graded subgrade surface minimizes, if not eliminates vertical adjustment of slabs after they have been set - **maximizing the number of slabs that can be placed during short installation windows.**

It is clear from the foregoing that a precise subgrade surface presents many benefits and is the key to rapid (overnight) replacement of precast concrete pavement slabs.

4. Bedding Material

The Super-grading process is facilitated by using "fine" bedding material that is easy to compact and grade by machine or by hand. This material, known in the Northeast as "stone dust" or screenings, is a by-product of most quarry operations and is commonly available in most areas. The gradation of this material is shown in **Table 1**.

BEDDING MATERIAL GRADATION

SIEVE SIZE DESIGNATION	PERCENT PASSING BY WEIGHT
½" MAX	100
NO. 4	80-100
NO. 10	55-75
NO. 40	10-40
NO. 200	0-20

Another benefit of using this material is that the finished compacted and supergraded surface is smooth and free from aggregate voids typical of those created when dense graded base materials are graded.

5. Providing a Fully Compacted Subgrade

To achieve full compaction, bedding material is placed in two passes. In the initial pass the material is placed and graded approximately ¼" high (to allow for compaction). The bedding material is then fully compacted with conventional compaction equipment. Conventional plate compactors and vibratory rollers are shown in **Figure 11** and **Figure 12**. After compaction a final super-grading (shaving) pass is made, leaving behind a precisely-graded, **fully compacted supergrade.**

Figure 11

Figure 12

7. Supergrading Equipment

The introduction of the Super-Slab® System has spawned the development of grading equipment that is capable of achieving the required accuracy in confined areas while operating in close proximity to heavy traffic. Laser-controlled concrete screeds have been modified for large-scale super-grading. Rail-supported hand-operated graders (H.O.G.) have also been developed for smaller areas such as patching areas. All are capable of supergrading fully compacted bedding material to the tolerance described above.

8. Laser-Controlled Grading for Larger Areas

The laser-controlled subgrade finisher seen in **Figure 13** has been developed by the Somero Corporation of Jaffrey, New Hampshire. This machine, called a Supergrader, is capable of finishing single or warped plane surfaces to the required accuracy at an approximate rate of 1500 to 2000 SF per hour. It is capable of grading either single or warped planes (with different control equipment) and is compact enough to work in most traffic-confined work areas.

Figure 13

Bobcat-mounted laser-controlled equipment is also now available and has proven to be very accurate, efficient, and cost-effective.

Operation of the Supergrader requires specialized training that is conducted by the Somero Corporation and is beyond the scope of this Manual. More information is available upon request.

9. Supergrading Small Areas with Hand Operated Graders

The Fort Miller Co., Inc. has developed four different models of hand operated graders that have been specifically designed for various types of repair projects. See the Fort

Miller "Hand Operated Grader Operating Manual" for details and further information about the complete family of equipment.

The basic Hand Operated Grader (H.O.G.) is shown in **Figure 14**. It consists of a wheel-mounted beam that spans the excavation to support a vibrating screed assembly. The wheels roll on pre-set rails that provide an accurate grade reference independent from the existing roadway surface. The H.O.G. is easily capable of grading at the approximate rate of 400 to 800 SF per hour, depending upon which model is used. On recent large-scale projects, grading rates in excess of 1500 SF per hour, matching or exceeding that of the Somero equipment, have been regularly achieved by contractors after a week or so of experience.

The H.O.G. may be used transverse to the highway as shown in **Figure 14** or longitudinally as shown in **Figure 15**. In both cases it is imperative to set the rails carefully to provide a grade reference that is correct and parallel to the desired finished surface.

Figure 14

Figure 15

If both rails shown in **Figure 15** are set vertically parallel (to each other), the H.O.G. will grade a single plane surface. If they are set at two different grades (non-parallel) a warped plane surface will result, where all sides are straight (parallel to the rails) and all cross sections are straight (as controlled by the beam-mounted screed) meeting the definition of a warped slab presented in Chapter 1. **If a warped surface is desired the rails should be set by a surveyor to achieve the correct 3-dimensional geometry.**

The H.O.G. is designed to grade the bedding material described in Table 1. **It is not designed to excavate compacted dense graded base material, new or old and it should not be used for that purpose.**

The operator of the H.O.G. is assisted by a man on each wheel, who push while the operator pulls to help keep the H.O.G. square to the rails. Most contractors also staff the grading crew with two other laborers to add and subtract stone dust as the area is graded. Such a crew can easily spread bedding material on the first pass and "shave" **compacted** material on the final pass since the screed portion of the H.O.G. is only 4' to 5' long.

Proper and efficient operation of the H.O.G. requires specialized training that is provided by the Fort Miller Co. This includes instruction in periodic checking of the screed depth settings to insure they have not slipped out of adjustment.

10. Other Grading Methods and Devices

The two types of grading devices described above have been used successfully to grade most of the Super-Slab® installed to date. Traditional screeds and string line grading methods, such as those shown in **Figure 16** and **Figure 17** have proven to be slow, inaccurate and **incapable of grading or trimming fully compacted bedding material to the required tolerance.** The roadway grader shown in **Figure 18** is too big for the area, too slow and incapable of achieving the required accuracy.

Figure 16

Figure 17

Figure 18

Use of these devices may result in un-compacted subgrade surfaces that compromise long term pavement performance. It may also result in non-uniform surfaces that may be a safety hazard if slabs placed upon them are opened to traffic before they are grouted. For these reasons, use of these poorly-controlled grading devices is not recommended.

11. Touching Up Around Edges

Hand tools, such as those shown in **Figure 19**, are useful and necessary for touch-up work and for grading around the edges of the hole. Skilled laborers who have an "eye" for grade and who are capable of grading to the required tolerance should be chosen to do this work.

Figure 19

If it is necessary to add bedding material in the touch-up process it must be fully compacted, the same as the rest of the bedding material, before the final grading pass is made.

Fort Miller can also supply an edge trimmer device that can run along the top surface of newly-placed slabs to ensure that the edge of the subgrade is properly graded. The blade depth and pitch are adjustable for each specific project.

12. Checking the Subgrade for Accuracy

It is a good practice to periodically check the subgrade surface for accuracy during the grading process. Stops and starts of the grading machine may leave high (or low) spots behind that should be identified and corrected. A 10’ straight edge, such as that shown in **Figure 20** is useful to identify variations in the surface (in the order of $\pm$ 3 mm) that are not perceptible to the eye.

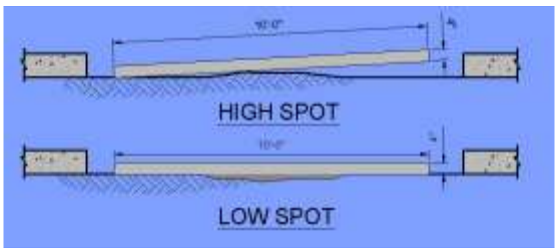


Figure 20

It is especially important to thoroughly check all edges of the hole that are inaccessible to the grading machine. The depth gage shown in **Figure 21** is useful for this purpose and can be used by both workmen and inspectors.

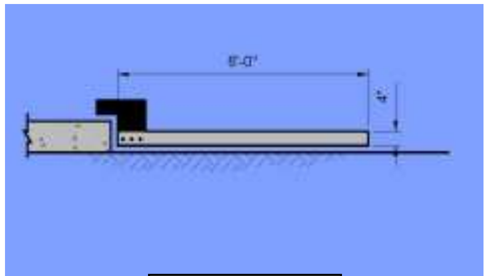


Figure 21

Routine and disciplined checking of the super grade surface is the best way to maximize the speed of the setting process. If a slab does not fit within tolerance, time is wasted while the slab is picked up again so the subgrade can be checked and re-graded. It is much easier and faster to make proper checks ahead of time so each slab can be set only once.

Chapter 5

Super-Slab® Installation

1. General

Once the supergrading is complete slab placement is relatively easy and straight forward. Since the elevations of the slabs are controlled by the subgrade surface the most important task of installing slabs is to get the slabs placed in the correct horizontal location.

Single drop-in slabs are simply centered in the prepared hole over the previously-installed dowels. If the dowels have been installed in their correct locations and the hole has been cut to the correct size, the centered slabs will result in joint widths that fall within the specified tolerance.

When placing a multiple of slabs in a single location it important to place them such that specified maximum joint widths are not exceeded. It must be kept in mind the actual lengths and width of fabricated slabs will actually vary but only within the allowable fabrication tolerances. The setting procedure detailed in the following sections ensures the resultant joint width between slabs do not exceed the maximum specified, and needs to be followed explicitly to achieve an acceptable installation. It also ensures the total length of the multiple of slabs does not creep, either big or small, during placement operations.

The size and type of setting equipment are important for efficient installation. Rubber-tired excavators can be used for slabs up to 10' in length. Modest-sized hydraulic cranes (45T to 65T capacity) are used on most Super- Slab® projects since they are compact enough to fit in a two-lane work space, yet large enough to lift standard-sized slabs effectively. Smaller or low-profile cranes may be necessary in confined work areas or in low clearance situations such as placement under bridges or under traffic signals at intersections.

In some extremely confined areas, such as in tunnels or under some bridges, slabs may need to be placed with loaders or high-capacity fork trucks. In these cases the slabs should be fabricated in sizes appropriate for the equipment used. At the very beginning of the project the contractor should decide what setting equipment will be used and have the precast slabs fabricated accordingly.

2. Slab Layout Drawings

A detailed slab layout drawing may not be necessary on intermittent repair projects where the majority of slabs are single "drop-in" type slabs. These slabs are typically single-planed and their locations can be managed by using tables that list sizes, stations, mile markers and lane numbers.

When a multiple of slabs are placed at any particular location it is advisable to develop a detailed slab layout drawing that shows mark numbers, female-male orientation, locations and elevations of all slabs. Since the female-male orientation determines the setting (placement) order of the slabs the contractor should participate in the development of the layout drawing prior to the fabrication of any slabs to ensure it is consistent with the planned installation operation.

The layout drawing indicates the location of every slab either by station or by two- or three-dimensional coordinates. The latter are necessary if the surface of the pavement is three dimensional to enable the precast designer to develop piece drawings that show the warp of every slab. This information is used for slab fabrication and for supergrading control just prior to installation.

To simplify the layout drawings, only the lay length (and width) lines are shown in the layout grid as shown in **Figure 22**. The lay length (width) of a slab is

Lay Length (width) = (TL or TW) + JW/2

Where "TL" ("TW") is the theoretical length (width) of the slab and "JW" is the maximum specified (allowable) joint width.

The theoretical length (width) of the slab is the nominal length (width). The actual length (width) of the slab, after fabrication, is

Actual Length (width) = TL (TW) $\pm$ the allowable slab fabrication tolerance.

The fabrication tolerance established by Fort Miller is 4 mm (3/16 in) $\pm$.

Theoretical slab lengths (and widths) are developed together during the shop drawing process such that the longest (or widest) slab allowed within the specified fabrication tolerance can be placed in the grid and will result in an actual joint width of near zero. If the shortest (or the narrowest) slab is placed within the grid the resulting actual joint width will be [JW/2 + 4 mm (3/16")], which is less than the maximum width allowed.

Maximum allowable joint widths are usually specified by the agency or owner of the project. For new construction these are frequently established as 12 mm (1/2") for both transverse and longitudinal joints. For intermittent repair, the allowable transverse joint width should be about 12 mm (1/2") and the allowable longitudinal joint width about 20 mm (3/4"). The larger allowable longitudinal joint width is necessary because of widely varying existing longitudinal joints.

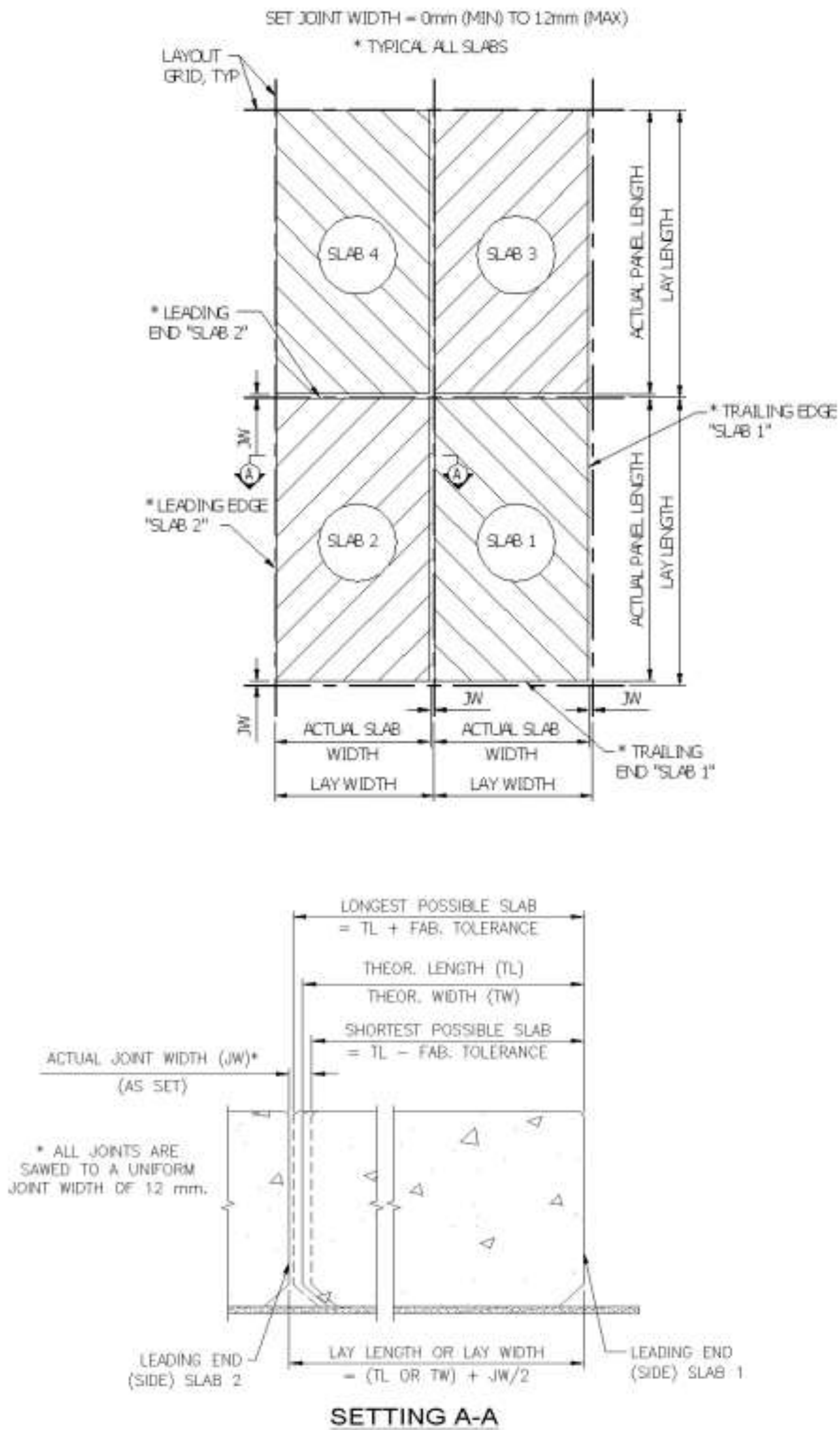

SET JOINT WIDTH = 0mm (MIN) TO 12mm (MAX)
* TYPICAL ALL SLABS
LAYOUT GRID, TYP
SLAB 4
SLAB 3
SLAB 2
SLAB 1
* LEADING END "SLAB 2"
* LEADING EDGE "SLAB 2"
* TRAILING EDGE "SLAB 1"
* TRAILING END "SLAB 1"
ACTUAL PANEL LENGTH
LAY LENGTH
JW
ACTUAL SLAB WIDTH
LAY WIDTH
LONGEST POSSIBLE SLAB = TL + FAB. TOLERANCE
THEOR. LENGTH (TL)
THEOR. WIDTH (TW)
SHORTEST POSSIBLE SLAB = TL − FAB. TOLERANCE
ACTUAL JOINT WIDTH (JW)* (AS SET)
* ALL JOINTS ARE SAWED TO A UNIFORM JOINT WIDTH OF 12 mm.
LEADING END (SIDE) SLAB 2
LAY LENGTH OR LAY WIDTH = (TL OR TW) + JW/2
LEADING END (SIDE) SLAB 1
SETTING A-A

Figure 22

3. Layout and Placement of Slabs

Prior to placing any slabs the lay lengths (and widths) described above are accurately laid out by a surveyor or by another qualified individual. **The leading end and leading edge of each slab are set to the grid lines described above without regard to the width of joint left behind.** If the lay length (and width) layout is correct, and the slabs are fabricated to specified tolerances, the width of the joints will be within the specified tolerance. Keep in mind that in most jurisdictions, the top 2" of all joints are later sawed to the specified width and depth and sealed as required.

4. A Final Check of the Subgrade Surface

It is advisable to make a final check of the subgrade surface just prior to placement of slabs to make sure it has not been disturbed after the final pass of the grading machine. Last minute checks and "fine tuning" are made with the checking devices and hand tools discussed in Chapter 4. Since it takes only one high spot to cause a high slab, attention given to this last minute check is well worth the effort.

5. Wetting the Subgrade Before Setting

Just prior to setting slabs the subgrade surface (bedding material) is lightly sprayed with water as shown in **Figure 23**. This is done to prevent dry subgrade material from "damming up" the flow of bedding grout when it is installed and to prevent "drying out" the bedding grout as it flows along the subgrade surface.

Figure 23

If the bedding material is already wet it may not be necessary to spray it. Judgment of the "wetness" of the bedding material must be exercised before proceeding to this step. Nevertheless, it is critical that appropriate equipment be provided by the contractor so that the subgrade can be watered at any time.

6. Applying Bond Breaker to Slabs and Dowels

Figure 24

Just prior to placement of each new slab bond breaker is sprayed or otherwise applied to the vertical end of the previously set slab and dowels that protrude from it, as shown in **Figure 24**, above. This lubricates the dowels and prevents dowel grout from bonding to both sides of the transverse joint, thereby minimizing potential break-up of the grout during subsequent expansion and contraction of the slabs.

Bond breaker is never applied to tie bars. It is applied to the longitudinal edge of the adjacent slab only if the latter is to be removed at a later time - to prevent spalling of the new slab when the adjacent slab is removed.

7. Rigging (Hooking up to) the Slab

Four coil threaded lift anchors are cast into each slab for lifting purposes. Lift bails are temporarily bolted to these to permit attachment of lift cables during lifting operations. Smaller slabs are typically lifted with equal length four-way cables or chains. Heavier slabs are lifted with two-way rolling sheave cables to ensure the capacity of the lifting inserts is not exceeded. The shop drawings will clearly indicate what type of lifting cables are to be used.

It is important to recognize that slabs lifted with equal length four ways will hang from the crane in a level position. If the subgrade is level the entire slab (and the four corners of the slab) will touch the ground at the same time.

Slab placement is facilitated if the entire slab (all four corners of the slab) touches the ground at the same time. If the subgrade has a significant cross-slope, it is advisable to adjust the cable lengths such that the entire slab hangs from the crane in a position that it is roughly parallel to the subgrade surface. This can be easily accomplished by using extra shackles in the appropriate legs of the set of cables or by using commercially-available four way grab chains.

Figure 25

The difficulty of placing slabs on a sloping subgrade with equal length four ways is illustrated in **Figure 25**. On the project illustrated in the photo the subgrade was pitched at a cross slope of 7/8" per ft. and at a grade of 4%. The corner of the slab that hit the ground first was not at the leading end and edge mark. By the time the slab was fully lowered into position it frequently did not end up at the mark making it necessary pick up the slab numerous times until it ended up in the right location. Much time could have been saved if proper length chains were used.

8. Controlling the Slabs During Setting

Figure 26

Tie-off ropes should be used for safe and controlled slab placement. As the slab is lowered into its final location, slab position is best maintained with steel rods (used as positioning handles) inserted into corner grout ports **(Figure 26). It is not advisable to use steel bars, wedges or any other devices in the joints for aligning purposes since they create large point loads that are apt to spall or chip the edges of the slab.**

9. Checking the Slabs for Surface Match

As soon as the slab is set the vertical match to adjacent slabs is checked as shown in **Figure 27**. In most cases slabs will match within the specified vertical tolerance if the specified grading procedures have been followed. In the unusual case a slab does not match, lift it and correct the subgrade as required to make the slab match within the specified tolerance **at this time.**

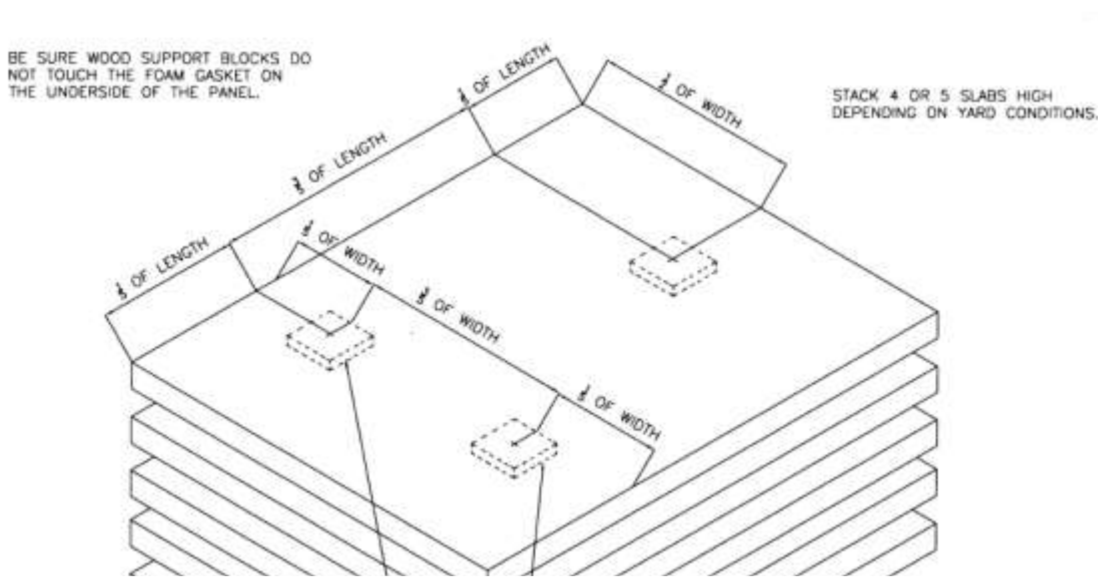
Note that, on continuous installations, the slab can not be easily picked up again after the next slab has been set!

A mismatch is usually the result of not checking the subgrade before setting the slab. If it occurs, more care should be given to checking before the next slab is set.

Figure 27

10. Storing Slabs on the Jobsite

On most projects, the slabs are shipped directly from the precasting plant to the crane hook for installation directly into the prepared hole. In some cases, it is necessary to store some slabs on the jobsite or in a temporary yard near the job. Care must be taken to properly store the slabs to prevent damage. Slabs should be stored on firm ground using 2” x 12” x 12” wooden dunnage, or similar. If slabs are stacked on top of each other, be sure that all dunnage is in a vertical stack above the dunnage below to make sure all forces are transmitted down through the wood and not applied to bending the concrete slabs. Always use **<u>only</u>** 3 pieces of dunnage arranged in a triangular pattern. This will ensure that each slab is fully supported with no bending forces applied to the slabs, as they can crack when unevenly loaded.



Chapter 6

Grouting Super-Slab

1. General

Dowel and bedding grouts described in Chapter 1 are vital to effective slab-to-slab interlock and full and complete slab support. It is absolutely vital that these grouts be designed, mixed, and installed properly for a successful long life slab installation. The following sections should be carefully read and understood before proceeding with Super-Slab® installation.

2. Dowel and Tie Bar Grout

Pre-bagged dowel and tie bar grout used to fill the inverted dovetail slots is a pumpable, rapid-setting non-shrink structural grout that completes the structural connection between adjacent slabs. A core taken from one such slot **(Figure 28)** shows how dowel grout completely fills the slot around the dowel creating the structural slab-to-slab interlock.

Figure 28

To be suitable for overnight Super-Slab® applications dowel grout must meet the following minimum critera:

1. The grout must be pumpable through a standard 1" grout hose
2. It must remain fluid for enough time to completely fill the slots.
3. It must reach a minimum strength of 17 Mpa (2500 psi) in about two hours (for most overnight work) before the slabs are opened to traffic.
2. It must reach a 28 day strength of 4500 psi.
3. It must meet all of the specified durability and shrinkage requirements required by Fort Miller and/or the specific DOT.

It should be pointed out that commercially available dowel bar retrofit backfill mortars typically meet all of the requirements except for the ones that pertain to pumpability, as they are meant to be troweled into place, not pumped. It is not acceptable to simply add water to these grouts to make them pumpable as additional water changes the formulation that was tested. All grouts considered for use, including backfill mortars, must be submitted to the appropriate Agency and Fort Miller for approval to certify their conformance to the criteria listed above, prior to their use on a Super-Slab® project.

As of this date **Dayton Superior HD-50** (mixed with 3.625 quarts/3.5 liters of water per bag) and **Pro-Spec Slab Dowel Grout** (mixed with 4.0 quarts/3.785 liters of water per bag) are the only grouts that have been approved for use in Super-Slab®. At least one more grout is awaiting approval at this time.

3. Trial Batching

Dowel grout is a pre-bagged material that must be mixed and used in strict accordance with the manufacturer's directions. The exact amount of water, the mixing time and the mixing equipment specified by the manufacturer should always be used.

It is important to conduct trial batches before installation **to determine how long it takes for the grout to achieve the specified opening strength of 2500 psi at the temperature anticipated at the time of installation**. Trials should be conducted and repeated until a reliable trend of "strength vs. time" is identified. The mix design that achieves the specified strength in the allotted time becomes the recipe that is used during actual grouting operations.

The rate of strength gain is determined by breaking standard 2" grout cubes at cure intervals comparable to those expected during the actual operation. It is important to use grout cubes and not concrete cylinders for grout testing, as the cylinders will give inaccurate results.

During actual grouting operations the grout temperature should be kept the same as the temperature of the corresponding trial batch. In hot summer weather, ice may be required to keep grout mixture temperatures cool. In cold weather it may be necessary to keep un-mixed grout (bags) in a warm place and to heat mixing water to bring the grout mixture **to the same level as the trial batch recipe** to ensure the same strength gain as the trial batch. Steps may also need to be taken to bring the slabs to a warmer temperature, as the mass of the colder slabs will quickly draw the heat from the relatively small grout mass.

4. Installing Dowel Grout

Before any grout is installed on the project, a Fort Miller technician will be made available to provide a grout training session for the contractor. This brief training session provides an opportunity to verify that the proper equipment (pump, hoses, water storage tank, generators, compressors, grout nozzles, hauling trailer, etc.) is available, functioning properly and compatible, and for the workmen to become familiar with the equipment and the unique properties of the grout. It is also an opportunity for mortar cubes to be made and tested to verify that all grout mixtures achieve the proper strength and other parameters. Fort Miller highly recommends that contractors take advantage of this opportunity, as the grouting operation can be problematic. Issues identified during the training session can be rectified before time and money is wasted during valuable night or weekend work windows.

The first step in installing dowel grout is to install foam grout seals in any open joints (typically at the shoulder end or interior end of transverse joints) to prevent the loss of dowel grout during the pumping operation. This is done by installing a bead of spray urethane foam at the end of the transverse joint. Also, the shoulder can be backfilled with specified shoulder material, recognizing that the backfill material needs to be fully compacted if it is to be left in place permanently.

While there are a variety of grout pumps commercially available, the two types used most frequently on Super-Slab® projects so far have been batch-type pumps made by the ChemGrout Company, and volumetric pumps made by Machine Technologies. A number of different models are available and it is therefore advisable to consult with the manufacturer directly to source the right pump for the project.

A typical ChemGrout batch-type pump, equipped to mix and to pump the grout, is shown in **Figure 29**. Grout is mixed in batches in a mixer chamber. After it has been thoroughly mixed it is then discharged directly into the grout pump hopper. While the grout is being pumped another batch can be mixed in the mixer.

Figure 29

Another type of pump that is becoming more popular is the Volumetric Mixing Pump. With this pump, the pre-mixed grout powder is poured into the storage hopper on the top of the pump. An electric motor turns an auger that moves the grout through a mixing chamber, where it is mixed with water that is flowing into the chamber from the water tank and water system. One major advantage of this type of pump is that the flow of grout can be continuous without stopping to mix batches and clean out the hoppers and hoses. A remote electric switch can also be mounted on the grout pipe so that the nozzleman can stop and start the flow of grout. This greatly eliminates any waste and also makes for a neater and cleaner job. With these pumps, the water meter needs to be carefully calibrated to ensure the proper water/cement ratio is maintained to achieve the proper grout strength before opening the road to traffic.

Figure 30

The dowel grout is installed by placing the grout nozzle in the back port of each slot until grout exudes from the port near the joint as shown in **Figure 30**. As soon as the grout comes out the second port the installer places a foot over that port to force the grout, under a little pressure, to fill the joint to at least the level 2” below the slab surface. The nozzle is then moved to the second slot and the procedure repeated. It is important to monitor the level of the grout in each port hole and to refill them as required.

The dowel grout materials described above gain strength rapidly and are known in the construction industry as “hot grouts”. **They must be mixed and pumped expeditiously to avoid grout setting up in the pump or in the line.** In short, the pump must be pumping either water or grout and it must never be stopped to allow grout to set in the line. For best results with the ChemGrout-type pumps, the mixer, the pump, and the hoses should be thoroughly cleaned after every 3 or 4 batches.

Do not drive on any freshly-grouted slab with any construction equipment or vehicle until the required grout strength of 2500 psi has been reached. To do so may result in deformation of uncured dowel grout compromising future efficiency of load transfer between slabs. Especially on intermittent patching projects, it is advisable to provide the grouting crew with a supply of cones or barrels so that the freshly-grouted slabs can be marked off to prevent construction traffic from inadvertently driving on the slabs until the grout has reached 2500 psi.

Dowel grout is always installed before the bedding grout to ensure dowel slots are filled with the right grout. Bedding grout is much more fluid than dowel grout and if it is installed first, it may leak past one of the bottom gaskets and flow into a dowel slot resulting in non-structural grout around the load transfer dowels.

6. Calculating Dowel Grout Quantities

A sample calculation for calculating the amount of dowel grout that is needed is shown in **Appendix A**. Keep in mind that joints must also be filled with dowel grout. Judgment should be exercised when ordering material to allow for possible waste due to low subgrades or to hot wasted batches caused by hot weather.

7. Bedding Grout

Bedding grout is used to fill any **voids** that may exist between the bottom of the slab and the subgrade surface, after the slab has been set. By virtue of the precise subgrade surface the slab is “essentially” subgrade-supported the moment it is placed in position and the bedding grout fills only the voids between the areas of subgrade contact.

Bedding grout is distributed to the voids by pumping the grout into ports that extend from the top of the slab to a series of half round grout channels that are cast in the bottom of the slab. A grout port is cast into the slab at each end of each channel making it possible to pump grout into one end of each port until it comes out the other, giving proof that the grout has reached any voids that exist along the channel. Foam gaskets attached to the bottom edges of the slab and midway between channels create a bounded bedding grout distribution system that enables positive filling of all voids.

6. Bedding Grout Mix Design

Bedding grout is a mixture of cement, water and plasticizing admixture designed to meet the following criteria:

a) The grout mixture must have a flow rate of 17 to 20 seconds as measured by ASTM C939 to insure fluidity
b) The mixture must reach a strength of 600 psi (4 Mpa) in 12 hours

The admixture is the same as that used in grout designed for rock bolts and post tensioning ducts, and contains water-reducing, shrinkage-compensating and thixotropic agents. The grout mixture is designed as designated by the manufacturer of the admixture. A technical sheet for one acceptable admixture is shown in **Appendix D**.

Trial batching, similar to that required for dowel grout, must be conducted with bedding grout to develop an acceptable formula that meets all of the specified criteria. A suggested recipe for bedding grout is shown in **Appendix B.** The temperature recommendations discussed in Section 3 are also applicable for bedding grout as well. As with the dowel grout trials, recipes identified at this time are to be used in actual grouting operations.

Pre-mixed and bagged bedding grout is now available. The advantage of using the pre-mixed material is that it eliminates variations due to mixing the components in the field. When using volumetric pumps, it is especially valuable because it eliminates the step of pre-mixing the dry components in the field before they are introduced into the hopper.

In colder temperatures it may be necessary to use an accelerator in the bedding grout mixture in order to achieve the required strength in the time frame allowed. The accelerator manufacturer should assist in selecting and specifying the type and required dosage of the accelerator. Pre-mixed, rapid setting bedding grout is now available from Pro-Spec.

Since the bedding grout described above is not tested nor approved for freeze-thaw durability or de-icing chemical resistance, the top two inches of all bedding grout port holes must be capped with dowel grout.

7. Installing (Pumping) Bedding Grout

The same grout mixer/pump used for dowel grout is used to mix and install bedding grout. Install the bedding grout by placing the grout nozzle in one of the bedding grout ports (painted red to distinguish it from a dowel grout port) as shown in **Figure 31**. Pump bedding grout until it exudes from the corresponding port at the other end of the grout channel, which

Figure 31

is an indication that the discreet grout chamber defined by the foam gaskets on either side of the grout distribution channel has been filled. After the chamber has been filled the grout seeps slowly into voids under the slab, as indicated by the lowering of the grout level in the ports. **It is important to keep adding grout in the ports to keep the level even with the top of the slab as this maintains enough grout pressure to ensure all voids under the slab are filled.**

Very little pressure is required to pump bedding grout through the distribution channel. If high pressure develops it is most likely the result of the grout distribution channel becoming plugged because of lumpy bedding grout (grout not properly mixed), grout setting up too quickly (because of hot weather) or dry bedding material creating a dam. All of these factors should be checked and corrected as necessary. The slab should be visually monitored throughout the pumping process to ensure increased pressure does not cause the slab to rise.

If grout fails to reach the end of the grout chamber and come out of the corresponding grout port it will be necessary to "back pump" from the terminal port. Before this is attempted check to make sure the bedding grout is properly mixed, lump free and flowing freely from the nozzle. Back pumping should only be allowed as a stop gap measure.

Glossary

Bedding Grout	A thin bedding grout material consisiting of cement, water and shrinkage compensating – plasticizing admixture designed to fill voids under previously-placed slabs
Bedding Grout Distribution System	A series of half-round channels cast into the bottom of the slab which enable complete distribution of bedding grout under the slab
Dowel Bars	Round load-transfer dowels that transfer load across transverse joints
Dowel Grout	Non-shrink structural grout pumped into inverted dovetail slots to encompass dowels or tie bars, completing the structural connection between slabs
Inverted dovetail slot	The dovetail shaped slot (informally referred to as a "mouse hole") cast in the bottom of slabs to encompass matching dowels or tie bars
Single Plane Slab	A slab whose entire surface resides in the same vertical plane
Stone Dust	Fine aggregate used as bedding material underneath slab with a maximum aggregate size of approximately 12 mm (1/2")
Super-grade	A fully compacted subgrade surface that is parallel to the finished pavement surface and is theoretically correct to within a tolerance of $\pm$ 3 mm (1/8")
Super-grading	A grading process that utilizes specialized laser or mechanically controlled grading devices to achieve a three dimensional subgrade surface that is theoretically correct to within a tolerance of $\pm$ 3 mm (1/8")
Tie bars	Deformed reinforcing bars that tie adjacent slabs together across longitudinal joints
Warped Plane Slab	A slab that has one corner above or below the vertical plane established by the remaining three corners and whose sides are vertically straight and whose cross sections taken at right angles to the long side are vertically straignt

Appendix A

Dowel Grout Quantity

Vol. Grout / Typ. Slab = No. Slots x Slot Vol. + Vol. under slab + Vol. Jts. + Vol. Chamfer

From Figure A.1

$$\text{Slot Vol.} = \frac{(W1 + W2)}{2} \times H \times L + 2 \times \left(\pi \times \frac{d^2}{4} \times h \right)$$

Where : W1 = bottom width of slot;

W2 = top width of slot;

H = slot height;

L = slot length;

d = diameter of grout port

Note: dimensions of transverse and longitudinal slots may vary.

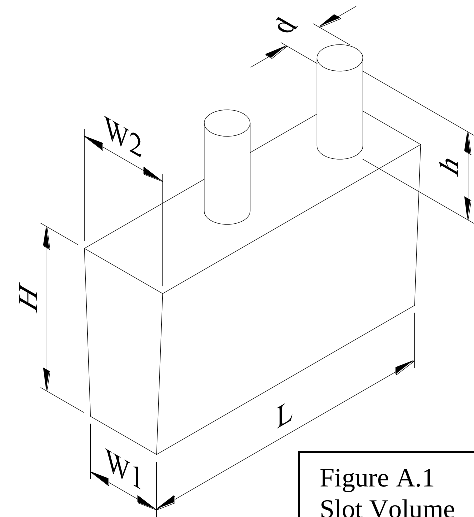


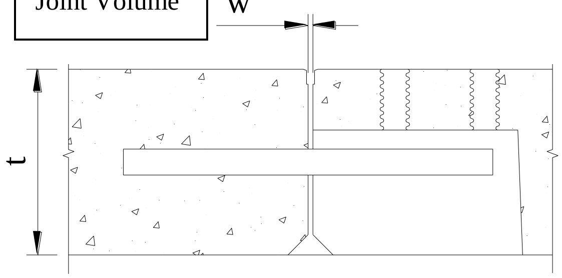
Figure A.1
Slot Volume

From Figure A.2:

$$\text{Vol. under slab} = \text{Area under slab} \times \text{estimated average grading accuracy}$$
$$\text{Area under slab} = Ws \times L\mathit{t} + (Ls - L\mathit{t}) \times L\ell$$

Where: Ls = slab length; Ws = slab width ;$L\mathit{t}$ = transverse slot length; $L\ell$ = longitudinal slot length

Figure A.3
Joint Volume



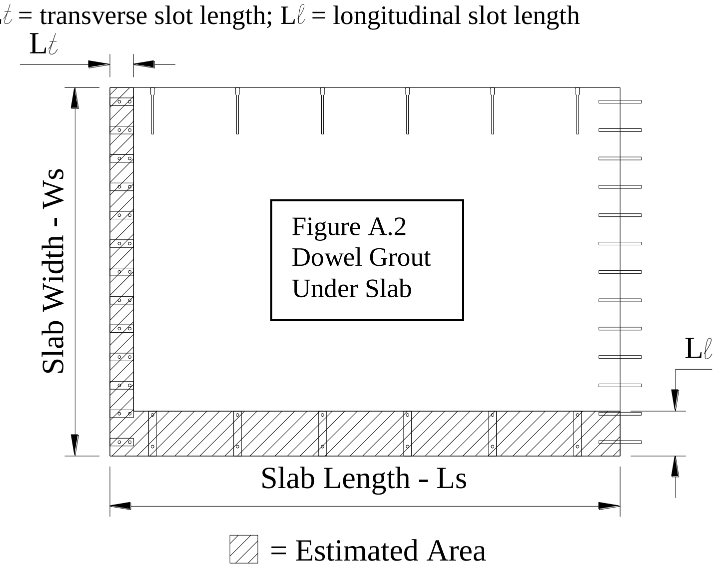


Figure A.2
Dowel Grout
Under Slab

From Figure A.3:

Vol. Jts. = (Ls + Ws + w) x w x t

Where: Ls = slab length;

Ws = slab width;

w = joint width;

t = slab thickness

From Figure A.2 and A.3:

Volume in Chamfer = 2 x (Ls +Ws) x [½ x 1” x 1”]

Metric Example – Dowel Grout Quantity (Assume Slab Size 3.962 M x 4.572 M) (13’ x 15’)

Transverse Slot

$$\text{Slot Vol.} = \frac{(65\text{ mm} + 75\text{ mm})}{2} \times 140\text{ mm} \times 254\text{ mm} + 2 \times \left(\pi \times \frac{(32\text{ mm})^2}{4} \times 75\text{ mm} \right)$$

Slot Vol. = 0.0026 m^3

No. Slot = 13

Vol. of Grout / Transverse Joint = 13 x 0.0026 m^3 = **0.0338 m^3**

Longitudinal Slot

Similar to Transverse but with L = 0.460 m

Slot Vol. = 0.0047 m^3

No. Slots = 6

Vol. of Grout / Transverse Joint = 6 x 0.0047 m^3 = **0.0283 m^3**

Volume Under Slab

Area under slab = 3.962 m x 0.254 m + (4.572 m – 0.254 m) x 0.460 m = 2.993 m^2

Estimated Average Grading Accuracy = 3 mm

Vol. Under Slab = 2.993 m^2 x 0.003 m = **0.009 m^3**

Volume in Joints

Vol. Jts. = (3.962 m + 4.572 m + 0.006 m) x 0.006 m x 0.215 m = **0.0110 m^3**

Volume in Chamfer (chamfer is 1” x 1” (25mm x 25mm)

Vol. Chamfer = 2 x (3.962 m + 4.572m) x [½ x 0.025m x 0.025m] **= 0.005 m^3**

Vol. Grout / Typ. Slab

Vol. Grout / Typ. Slab = 0.0338 m^3 + 0.0283 m^3 + 0.009 m^3 + 0.011 m^3 + 0.005 m^3 = **0.0871 m^3**

It is recommended that 20% waste be added to the final volume for estimating purposes. For smaller projects, or on single-weekend closures, 20% may not be enough.

What most contractors have found to be a good strategy on larger jobs is to order enough grout for about half the job, or as much as a truckload to get good volume pricing. Monitor the grout usage for a while to verify quantities, then order the balance of the required grout.

Appendix B

BEDDING GROUT

Required Properties

Flow Rate of 17-20 seconds through a standard ASTM C939 Flow Cone (½” opening)

Compressive Strength 600 psi in 12 hours (cubes)

Suggested Bedding Grout Mix Design *

Cement – 5 (94 lbs) bags = 470 lbs (Type III Portland Cement)

Water – 26 gals (0.46 w/c)

MasterRoc® FLC100 - 1 (25 lbs) bag (5.32% of Portland Cement)

Bedding Grout Yield per 5 (94 lbs) Bag Batch

Bedding Grout Yield per 5 (94 lbs) Bag Batch

Component	Absolute Volume
$\text{Cement- } 5\,\text{bags} \times 94\frac{\text{lb}}{\text{bag}} \times \frac{1}{3.15 \times 62.4\frac{\text{lb}}{\text{ft}^3}} = 2.39\,\text{ft}^3$	2.39 ft^3
where 3.15 is the specific gravity of cement	
$\text{Water - }0.46(\text{w/c}) \times 94\frac{\text{lb}}{\text{bag}} \times \frac{5\,\text{bags}}{62.4\frac{\text{lb}}{\text{ft}^3}} = 3.465\,\text{ft}^3$	3.465 ft^3
$\text{MasterRoc FLC100 - }1\,\text{bag} \times 25\frac{\text{lb}}{\text{bag}} \times \frac{1}{2.2 \times 62.4\frac{\text{lb}}{\text{ft}^3}} = 0.182\text{ft}^3$	0.182 ft^3
where 2.2 is the specific gravity of Master Roc® FLC 100	
	6.038 ft^3

For estimating purposes assume 1 cubic foot bedding grout yields 48 SF at ¼” thick.

* Actual quantities may vary to meet required flow rate of 17-20 seconds and a compressive strength of 600 psi in 12 hours.

APPENDIX C

DAYTON SUPERIOR®
Chemical & Cement Products

Technical Data

HD-50™
Rapid Setting Heavy Duty Flowable Repair Mortar

PRODUCT DESCRIPTION:

HD-50 is a fast setting, fiber reinforced, latex modified, heavy duty concrete repair mortar designed for areas where a rapid strength gain is required to minimize downtime. HD-50 is a cement based compound having similar characteristics to normal portland cement mixes and is bondable and compatible with portland cement concrete. It does not contain chlorides or magnesium phosphates.

HD-50 is a one component product requiring only water to mix and apply, simplifying restoration of concrete surfaces. Areas repaired with HD-50 can be opened to traffic within one hour because the compressive strength of the patch is already in excess of 2,000 psi.

PURPOSE:

HD-50 is a rapid setting, cement based concrete mortar designed for the repair of heavy duty surfaces such as concrete highways, bridge decks, parking structures, airport runways, freezer rooms, industrial and warehouse floors, and loading docks.

HD-50 is a flowable material and is not designed for vertical and overhead patching, unless the repair is formed. HD-50 can be installed in weather as cold as 10°F (-12°C), provided cold weather instructions are followed.

ADVANTAGES:

- Can be opened to use or traffic within 60 minutes.
- High compressive strength quickly – over 2,000 psi in one hour.
- Resists salt penetration and damage from freeze/thaw cycles.
- Contains no chlorides or magnesium phosphate (not a chemical concrete).
- Meets ASTM C-928; Specification for Very Rapid Hardening Cementitious Repair Materials.
- Can be applied in cold temperatures down to 10°F (-12°C), if cold weather instructions are followed.
- Non Corrosive.
- Bondable and compatible with portland cement concrete.
- Aggregate Extension – Up to 60% on repairs greater than 2 inches (5cm) deep.

SPECIFICATIONS:

Meets ASTM C-928: As a Type R-3 mortar which includes the following tests:

1. Compressive Strength – ASTM C-109

	At 75°F (24°C)	At 40°F (4°C)	At 100°F (38°C)
1 Hour	2500 psi (17.2 MPa)	–	–
3 Hours	3500 psi (24.1 MPa)	2700 psi (18.5 MPa)	5100 psi (35.1 MPa)
1 Day	6145 psi (42.4 MPa)	6100 psi (42.0 MPa)	6300 psi (43.4 MPa)
7 Days	7370 psi (50.8 MPa)	6860 psi (47.3 MPa)	7300 psi (50.3 MPa)
28 Days	7990 psi (55.1 MPa)	7800 psi (53.8 MPa)	8500 psi (58.6 MPa)

2. Bond Strength ASTM C-882
   1 day 1,950 psi (13.4 MPa)
   7 days 2,250 psi (15.5 MPa)

3. Length Change of Hardened Cement Mortar and Concrete ASTM C-928

Change	Water Storage	Air Storage	Differential
28 Days	+.051%	-.082%	.133%
ASTM C-928	Max. to .15%	Max. to -.15%	Max. .20%

4. Scaling Resistance (Freeze/Thaw) - ASTM C-672 Average of 3 specimens:
   Scaling Resistance - .71 lbs./ft² (3.5 kg/m²)
   ASTM C-928 Spec. - 1.0 lbs. /ft² (4.9 kg/m²)

5. Rapid Freeze/Thaw Test: ASTM C-666
   At 300 Cycles - No loss.

6. Chloride Ion Permeability - ASTM C-1202
   Elapsed Time - 360 minutes
   Chloride Permeability Rating - Very Low

SURFACE PREPARATIONS:

For best results follow the ACI standards for concrete preparation, removing all residue, grease, dirt, oil, etc. from the surfaces to be in contact with the repair material. All loose concrete must be removed until firm substrate is exposed. Saw cut the perimeter of the repair to a maximum depth of 1/2" (1.3 cm). Best results will be obtained by saw cutting the area to be repaired, providing uniform depth, a high surface profile and firm bonding areas. Minimum repair depth of 1/2" (1.3 cm) is required. All surfaces to be repaired should be in a saturated surface dry (SSD) condition with no standing water on the surface. A scrub coat or an approved bonding agent like Dayton Superior Ad Bond (J-40) is recommended.

Dayton Superior Chemical & Cement Products 3 CONCRETE

For Commercial/Industrial Use Only

DAYTON SUPERIOR®
Chemical & Cement Products

Technical Data

PLACEMENT INSTRUCTIONS:

When mixing less than a full bag, always first agitate the bag so that a representative sample is obtained. HD-50 requires only water for mixing at the rate of 3.25 qts. (3L) per 50 lbs. (22.7 kg) of material. Place water into the mixing container and then add the repair material to the water. The product can be mixed with a mud paddle in a 5 gal. (18.9L) container, or can be mixed in a mortar mixer, preferably with rubber-tipped blades. Continue mixing until the material is free of lumps (approx. 3-5 minutes). Mix as close as possible to the area to be repaired. Do not allow material to build up on equipment and wash periodically with water. Do not re-temper the mixed material or use admixtures. Place immediately after mixing, working the material firmly into the sides and bottom to eliminate air pockets and assure maximum bond. Where practical, work from one side to the other and screed to the level of the surrounding concrete. Trowel the surface or provide a desired finish. Working time is 15 minutes. HD-50 should be extended 60% by weight with clean 3/8" (1.0 cm) pea gravel on patches deeper than 2" (5 cm). For aggregate extension greater than 60%, contact Dayton Superior. On hot or windy days, a moist cure for 1 hour is recommended, or apply one of Dayton Superior water based curing compounds, such as J-18 or J-11-W.

HOT AND COLD WEATHER APPLICATIONS:

COLD - HD-50 can be applied in temperatures down to 10°F (-12°C), provided these instructions are followed. When applied in cold weather (below 40°F, 4°C), heat the surrounding concrete until warm to the touch. Warm the repair material and use approx. 90°F (33°C) mixing water. After placement, the repaired patch should be covered with a construction insulating blanket for a minimum 1-3 hours to keep material from freezing and to assure proper set and bond.

HOT - When placing the material in hot weather, cold water should be used as a mixing agent. Ambient and water temperatures will affect the setting time. Colder temperatures will extend the setting time, and warmer temperatures will shorten the setting time. At 70°F (21°C), the initial setting time is between 15 and 20 minutes. In applications where temps. are above 90°F (33°C) it is recommended the repair area be soaked with water, or use of an approved bonding agent like Dayton Superior Ad Bond (J-40) be applied to prevent the rapid loss of the moisture in the patch material. The repair area should be covered with wet burlap or one of Dayton Superior water based curing compounds, such as J-18 or J-11-W.

YIELD:

.42 cubic ft. per 50 lb. (.012 m³/ 22.7 kg) bag
.60 cubic ft. per 50 lb.(.017 m³/22.7 kg) bag with 60% extension (30 lbs. or 13.6 kg) with 3/8" (1 cm) pea gravel.

PACKAGING:

50 lb. (22.7 kg) bags, 50 bags per pallet

LIMITATIONS:

Do not attempt to retemper HD-50 after initial mixing. Do not add other cements or admixtures. HD-50 is a fast-setting product and mixing equipment should be cleaned with water at the earliest time. Shelf life of this material is approx. one year. Store on pallets in a cool, dry area and free from direct sunlight.

WARNING:

Skin is sensitive to cement. Wearing protective gloves and goggles is recommended. Avoid contact with eyes. Avoid prolonged contact with skin. Contains portland cement. Wash exposed skin promptly with water. May cause skin irritation as well as cement burns. In case of eye contact, flush eyes repeatedly with clean water and contact a physician. Harmful if ingested. Read MSDS before using product.

TECHNICAL SERVICES:

Contact the technical staff for assistance at:

1-866-329-8724 • 1-913-233-1750 • FAX: 1-913-279-4806

daytonsuperiorchemical.com

WARRANTY

Warranty, Warranty Disclaimer and Exclusive Remedy – Dayton Superior Corporation warrants, for 12 months from the date of manufacture or for the duration of the published product shelf life, whichever is less, that at the time of shipment by ("the Company"), the product is free of manufacturing defects and conforms to ("the Company's") published specifications in force on the date of acceptance by ("the Company") of the order. ("the Company") shall only be liable under this warranty if the material has been applied, used, and stored in accordance with ("the Company's") instructions in the product's technical data sheet.

The purchaser must examine the product when received and promptly notify ("the Company") in writing of any non-conformity before the product is used, or no later than 30 days after such non-conformity is first discovered. If ("the Company"), in its sole discretion, determines that the product breached the above warranty, it will, in its sole discretion, replace the non-conforming product, refund the purchase price or issue a credit in the amount of the purchase price. This is the sole and exclusive remedy for breach of this warranty.

Only a ("Company") officer is authorized to modify this warranty. The sales information on the ("the Company's") website and received by the customer during the sales process does not supersede this warranty and the specifications of the product in force on the date of sale. THE FOREGOING WARRANTY SHALL BE EXCLUSIVE AND IN LIEU OF ANY OTHER WARRANTY, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND ALL OTHER WARRANTIES OTHERWISE ARISING BY OPERATION OF LAW, COURSE OF DEALING, CUSTOM, TRADE OR OTHERWISE.

Limitation of Liability – Dayton Superior Corporation shall not be liable in contract or in tort (including, without limitation, negligence, strict liability or otherwise) for loss of sales, revenues or profits; cost of capital or funds; business interruption or cost of downtime, loss of use, damage to or loss of use of other property (real or personal); failure to realize expected savings; frustration of economic or business expectations; claims by third parties (other than for bodily injury), or economic losses of any kind; or for any special, incidental, indirect, consequential, punitive or exemplary damages arising in any way out of the performance of, or failure to perform, this Agreement, even if ("the Company") could foresee or has been advised of the possibility of such damages. The Parties expressly agree that these limitations on damages are allocations of risk constituting, in part, the consideration for this agreement, and also that such limitations shall survive the determination of any court of competent jurisdiction that any remedy provided in these terms or available at law fails of its essential purpose.

Dayton Superior Specialty Chemical Corp • 4226 Kansas Avenue, Kansas City, KS 66106
Telephone (913) 233-1750 • Fax (913) 279-4806 • daytonsuperiorchemical.com

HD-50
Technical Application Bulletin

Application of the HD-50 as a dowel grout for the Super Slab™ Full Depth Pavement Replacement Slab System

When used in the Super Slab™ System it is recommended to pump the HD-50 using a maximum water content of 3.625 qts./50 lb. [3.43 L/22.7 kg] bag.

The following HD-50 test data is representative @ the 3.625 qts.[3.43L]:

Property	Test Results
Compressive Strength (1 hour)	12.7 Mpa [1842 psi]
Compressive Strength (3 hour)	22.8 Mpa [3306 psi]
Compressive Strength (24 hour)	31.5 Mpa [4568 psi]
Compressive Strength (28 day)	53.4 Mpa [7743 psi]
Expansion (%)	0.06%
Freeze/Thaw (% loss)	0.0%
Bond Strength	2.8 Mpa [406 psi]
Set Time (minutes)	37 min.

For application or product questions call the technical services group @ 866-329-8734

PRO SPEC®
A SAKRETE BRAND

SLAB DOWEL GROUT

Mixing

1. Mix as close to the area being repaired as possible. Slab Dowel Grout requires only the addition of water.
2. Use 4 quarts (3.8 L) per 50 lbs. (22.7 kg). Place the potable water into the mixing container and then while mixing add the grout.
3. Slab Dowel Grout can be mixed in a mortar mixer or by using a paddle attached to a heavy duty 1/2" drill (650 r.p.m.).
4. Mix for 2-3 minutes to a lump-free consistency.
5. Do not retemper or overwater.

Application

Slab Dowel Grout completes the structural connection between adjacent slabs and is therefore a very important part of the Super-Slab System®. It is a special pumpable rapid strength mix design for filling and connecting dowels and must completely fill the inverted dovetail slots and do the job that cast in place concrete normally does. And for it to make the Super-Slab System® viable it must reach strength quickly and perform as well as cast-in-place concrete. ProSpec Slab Dowel Grout meets these stringent requirements minimizing down time and insuring durability.

Place immediately after mixing working the grout firmly into the sides and bottom of the cavity eliminating air pockets and insuring bond and coverage. ProSpec Slab Dowel Grout can also be placed by pumping. Because of the early strength gain the grout must be pumped rapidly to avoid having the grout set-up in the pump or hose. It is important to pre-test insuring that the technique and equipment is suitable for the task. Install the ProSpec Slab Dowel Grout by placing the hose nozzle in the back port of each slab until grout exceeds from the port near the joint. Continue pumping until the grout fills the joint as specified in the Fort Miller installation drawings. After several slots have been filled, monitor the grout level in previously grouted ports and add material as required.

CAUTION! Do not drive on any freshly grouted slab with any construction equipment or vehicle until the specified grout strength of 2500 psi (17.2 MPa) has been reached. To do so may compromise future efficiency of load transfer between slabs. Follow installation instructions as outlined by the Fort Miller Co. Inc. Super Slab System® pertaining to precast concrete placement slab installation (518.695.5000).

Clean Up

Use water to clean all tools immediately after use.

PRE-BLEND

2

PRO SPEC®
A BAKRETE® BRAND

SLAB DOWEL GROUT

Description

ProSpec® Slab Dowel Grout is a non-shrink high compressive strength, non-metallic grout used for placing prefabricated concrete pavements.

Features

- Over 2500 psi (17.24 MPa) compressive strength in 2 hours
- Meets ASTM C 928, Standard Specification for Packaged, Dry, Very Rapid Hardening Cementitious Materials for Concrete Repair
- Non-shrink
- Special mix design formulated to meet the requirements of the Fort Miller Co. Inc. Super Slab System®
- Excellent bond
- Resists freeze/thaw damage
- High fluid – can be pumped through 1 1/4" grout hole ports
- Cement based, non-corrosive – not a chemical concrete
- Non-metallic

Uses

- Specifically designed to complement precast concrete slab placement
- Fill inverted dovetail slots in precast slabs

Technical Data

Working Time @ 70° F (21° C)	
30 minutes; pumpable for 20 minutes	
Set Time ASTM C 191 @ 70° F (21° C)	
Initial set	Approx. 35 min.
Final set	Approx. 40 min
Compressive Strength ASTM C 109 @ 75° F (24° C)	
2 hours	2,500 psi (17.2 MPa)
3 hours	4,000 psi (27.5 MPa)
1 day	5,200 psi (35.8 MPa)
7 days	6,200 psi (42.7 MPa)
28 days	7,500 psi (51.7 MPa)
Test Length Change of Hardened Cement Mortar and Concrete ASTM C 928	
Change (28 days)	ASTM C 928 requirement
Water storage	+0.04% (max. to 0.15%)
Air storage	-0.01% (max. to -0.15%)
Differential	0.14% (max. 0.20%)

Freeze/Thaw Test (using 2" cubes); NY DOT Test Method 701-13F/502-3P

Mixing water	8.0 qts./100 lbs.
Method of curing	7 days @ 72° F, 50% RH

Testing results using a NaCl solution

	3% NaCl solution	10% NaCl solution
Loss after 25 cycles	No loss (weight gain of 1.01%); Condition of specimens: slight surface popping, 5%	No loss (weight gain of 1.43%); Condition of specimens: no visible degradation
Loss after 50 cycles	no loss (weight gain of 1.51%); Condition of specimens: slight surface popping, 30%	No loss (weight gain of 2.38%); Condition of specimens: slight surface popping, <5%

Test results obtained under controlled laboratory conditions.
Reasonable variations can occur due to atmospheric and jobsite conditions.

PRE-BLEND PRODUCTS, INC.

PRO SPEC
A SAKRETE BRAND

SLAB DOWEL GROUT

Best Performance

- Do not re-temper after mixing
- Do not over water or add other cements or additives
- Ideal ambient, surface and material temperatures are in the range of 40° to 100° F (4° to 38° C) for mixing and placing.
- Ideal mixed product temperature at placement is 65-70° F (21° C), where the initial setting time is 35 minutes. Hot temperatures will shorten setting time, while cold temperatures will extend setting time
- Hot Weather: Keep bagged Slab Dowel Grout cool. Mix Slab Dowel Grout using ice water to extend working time
- Cold Weather: Do not use antifreeze or accelerators and keep Slab Dowel Grout warm. Combine the warmed repair material with 90° F (32° C) mixing water

Refer to

- ACI 305 Standard on Hot Weather Concreting
- ACI 306 Standard on Cold Weather Concreting

Yield

50 lbs. (22.7 kg) yields approximately 0.45 ft³ (7 m³)
50 lbs. (22.7 kg) extended with 30 lbs. (14 kg) of ⅜" (10 mm) pea gravel yields approximately 0.65 ft³ (10 m³)

Packaging

50 lbs. (22.7 kg) moisture resistant bag

Storage

Keep in cool/dry place unexposed to sunlight and tightly reseal container.

Shelf Life

One year when stored properly in original unopened container.

PRE-BLEND PRODUCTS, INC.

3

PRO SPEC®

A SAKRETE BRAND

SLAB DOWEL GROUT

Caution

KEEP OUT OF REACH OF CHILDREN AND ANIMALS. WARNING!

Contains Portland cement and silica sand. May irritate eyes and skin. Avoid contact with eyes or prolonged contact with skin. In case of contact, flush thoroughly with water. The wearing of gloves and safety goggles is recommended.

In case of eye contact, flood eyes with potable water and call physician. DO NOT RUB EYES. Do not take internally. Crystalline silica sand may cause serious lung problems. Avoid breathing dust and wear a respirator in dusty areas.

Consult Material Safety Data Sheet for further information.

First Aid

Inhalation: Remove to fresh air

Eye Contact: Irrigate eye with water or consult physician if irritation persists.

Skin Contact: Washed exposed skin area with soap and water; consult a physician if irritation persists.

Ingestion: Immediately consult a physician.

PRE-BLEND PRODUCTS, INC.

REV 12/07

APPENDIX D

BASF
The Chemical Company

31	31 33 00	Rock Stabilization
	31 51 00	Anchor Tiebacks
	31 68 00	Foundation Anchors

MasterRoc® FLC 100

Powdered Additive for Cementitious Grouts

Formerly MEYCO Flowcable*

Description

MasterRoc FLC 100 is a special multicomponent rheoplastic additive used in cement-based grouts to reduce the mixing water requirements and produce a flowable, pumpable, thixotropic, non-shrink, non-segregating, high-strength grout with any type of portland cement. MasterRoc FLC 100 additive is used in grouts for rock and ground support and stabilization, as well as grout used for the protection of post-tensioned cables in prestressed concrete and for full encapsulation of tunnel and mine rock bolts and anchors.

Applications

Recommended for use in:

- Neat cement or cement-sand grouts for anchoring applications in rock and concrete
- Grouts used in tunneling, dams, mining or other geotechnical operations
- Preplaced aggregate grouting
- Contact and consolidation grouting

Features

When used in the recommended applications, MasterRoc FLC 100 additive produces a thixotropic grout with the following unique properties:

- Low water-cement ratio
- Bleedwater control
- High-early strength[1]
- Long potlife (open time)[1]
- High ultimate strength[1]

[1] *These parameters are dependent upon the type of cement used in the grout.*

Benefits

- Pumps and places more easily
- Shrinkage-compensating
- Dense and compact, ensuring maximum protection of steel members against corrosion caused by aggressive agents

Performance Characteristics

Dosage: MasterRoc FLC 100 additive is formulated to be used at a dosage in the range of 2.5-6.0 lb/cwt (2.5-6.0 kg/100 kg) of cementitious material. Dosages may vary according to application and desired concrete properties. For dosages outside the recommended range, contact your local sales representative.

Mixing: MasterRoc FLC 100 additive should be uniformly distributed in the mixing water when possible before the other solids are added.

Product Notes

MasterRoc FLC 100 additive is not recommended for precision grouting of machinery, column bases, etc.

MASTER®
» BUILDERS
SOLUTIONS

Storage and Handling

Storage Temperature: MasterRoc FLC 100 additive should be stored in unopened packaging in clean, sheltered, dry conditions between 50 and 90 °F (10 and 32 °C).

Shelf Life: MasterRoc FLC 100 additive has a shelf life of 12 months when properly stored. Depending on storage conditions, the shelf life may be greater than stated. Please contact your local sales representative regarding suitability for use if the shelf life of MasterRoc FLC 100 additive has been exceeded.

Packaging

MasterRoc FLC 100 additive is supplied as a dry powder in 25 lb (11.4 kg) moisture resistant bags.

Related Documents

Safety Data Sheets: MasterRoc FLC 100 additive.

Additional Information

For additional information on MasterRoc FLC 100 additive, contact your local sales representative.

The Admixture Systems business of BASF's Construction Chemicals division is the leading provider of solutions that improve placement, pumping, finishing, appearance and performance characteristics of specialty concrete used in the ready-mixed, precast, manufactured concrete products, underground construction and paving markets. For over 100 years we have offered reliable products and innovative technologies, and through the Master Builders Solutions brand, we are connected globally with experts from many fields to provide sustainable solutions for the construction industry.

Limited Warranty Notice

BASF warrants this product to be free from manufacturing defects and to meet the technical properties on the current Technical Data Guide, if used as directed within shelf life. Satisfactory results depend not only on quality products but also upon many factors beyond our control. BASF MAKES NO OTHER WARRANTY OR GUARANTEE, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO ITS PRODUCTS. The sole and exclusive remedy of Purchaser for any claim concerning this product, including but not limited to, claims alleging breach of warranty, negligence, strict liability or otherwise, is shipment to purchaser of product equal to the amount of product that fails to meet this warranty or refund of the original purchase price of product that fails to meet this warranty, at the sole option of BASF. Any claims concerning this product must be received in writing within one (1) year from the date of shipment and any claims not presented within that period are waived by Purchaser. BASF WILL NOT BE RESPONSIBLE FOR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL (INCLUDING LOST PROFITS) OR PUNITIVE DAMAGES OF ANY KIND.

Purchaser must determine the suitability of the products for the intended use and assumes all risks and liabilities in connection therewith. This information and all further technical advice are based on BASF's present knowledge and experience. However, BASF assumes no liability for providing such information and advice including the extent to which such information and advice may relate to existing third party intellectual property rights, especially patent rights, nor shall any legal relationship be created by or arise from the provision of such information and advice. BASF reserves the right to make any changes according to technological progress or further developments. The Purchaser of the Product(s) must test the product(s) for suitability for the intended application and purpose before proceeding with a full application of the product(s). Performance of the product described herein should be verified by testing and carried out by qualified experts.

[1] MEYCO Flowcable became MasterRoc FLC 100 under the Master Builders Solutions brand, effective October 1, 2013.

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Admixture Systems
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APPENDIX E

PRO SPEC®

BEDDING GROUT[1]

Description
ProSpec® Bedding Grout is a non-shrink high compressive strength, non- metallic grout used for placing prefabricated concrete pavements.

FEATURES:

• Over 3500 psi
compressive strength in 24 hours
• Special mix design formulated to meet the requirements of the Fort Miller Co. Inc. Super Slab System®
• Excellent bond
• Resists freeze/thaw damage
• High fluid – can be pumped through 1 1/4" grout hole ports
• Cement based, non-corrosive – not a chemical concrete
• Non-metallic•

USES:
• Ideal for bedding grout for precast concrete roadway panels,

Technical Data:
Compressive Strength ASTM C 109
1 day >3500 psi
7 days > 7000 psi
28 days >8000 psi
Flow (cone) ASTM C939
<30 Seconds

Mixing Requirements
Mixing Water 7 qts/35 lb. bag (41.7%).
Water can be adjusted for +/- 5% based on ambient conditions and jobsite situations.
Curing Method ASTM C 1107

1. Mix as close to the area being repaired as possible. ProSpec Bedding Grout requires only the addition of water.

2. Use 7 quarts+/- 5% based on ambient conditions and jobsite situations to 35 lbs. bag (41.7%) Place the potable water into the mixing container and then while mixing add the grout.
3. ProSpec Bedding Grout can be mixed in a mortar mixer or by using a paddle attached to a heavy duty 1/2" drill (650 r.p.m.).
4. Mix for 2-3 minutes to a lump-free consistency.
5. Do not retemper or overwater.

Application: (Note: Always install ProSpec Slab Dowel Grout before Bedding Grout. Do not drive on any slab with any construction equipment or vehicle until the Dowel Grout has achieved 2,500 psi [17.2 mPa]. To do so may compromise future efficiency of load transfer between slabs.)
ProSpec Bedding Grout is a special mix design formulated to meet the requirements of Bedding Grout for use in the Fort Miller Co., Inc. Super Slab System. The purpose of bedding grout is to fill any small voids that may exist between the slab and the prepared subgrade after the "supergrading" process has been completed. Bedding grout is installed by pumping into the bedding grout distribution system cast into the underside of each slab. Pump the grout into the lowest of the two connected ports and keep pumping until grout exudes from the uphill port. The bedding grout is very fluid, but the grout will take a short while to disperse beneath the slab, so that the port will need to be refilled occasionally until the level ceases dropping in the port. The refilling is easily accomplished by a laborer who tops off the ports from a pail, pouring the grout directly into the port, or into plastic funnels provided by Fort Miller for this purpose. Continue with the pumping of bedding grout into each distribution channel until all the channels in each slab have been grouted. Leave the bedding grout level down 2" from the top of the slab (or remove grout if required) and cap off with ProSpec Slab Dowel Grout.

For Super Slab Systems* installations, follow installation instructions as outlined by The Fort Miller, Co. Inc. (518-695-5000; www.FortMiller.com).

*Patented system by The Fort Miller Co.

Clean up:
Use water to clean all tools immediately after use.

Best Performance:
Do not re-temper after mixing
• Do not over water or add other cements or additives
•When grouting slab connectors the ProSpec Slab Dowel Grout may be driven on by construction equipment and vehicles once it has achieved 2,500 psi (17.2mPa) regardless of the strength achieved by the bedding grout.
• Ideal ambient, surface and material temperatures are in the range of 40º to 100º F (4º to 38º C) for mixing and placing.
• Ideal mixed product temperature at placement is 65-70º F (21º C), where the initial setting time is 35 minutes. Hot temperatures will shorten setting time, while cold temperatures will extend setting time
• Hot Weather:
Keep bagged ProSpec Bedding Grout cool. Mix ProSpec Bedding

Grout using ice water to extend
working time
• Cold Weather:
Do not use antifreeze or
accelerators and keep ProSpec Bedding
Grout warm. Combine
the warmed repair material with
90º F (32º C) mixing water

Refer to
• ACI 305 Standard on Hot
Weather Concreting
• ACI 306 Standard on Cold
Weather Concreting

Packaging:
35 lb. bags

Yield:
35 lb. bag = 0.41 Cubic Feet

Storage:
Keep in cool/dry place unexposed to sunlight and tightly reseal container.

Unit weight:
120 pounds per cubic foot.

Shelf Life:
One year when stored properly in original unopened container.
Keep in cool/dry place unexposed to sunlight and tightly reseal container.
35 lbs. moisture resistant bag

APPENDIX F

Equipment and Materials Required for Super-Slab® Installation

(Updated February 26, 2014) (Equipment by Fort Miller in BOLD)

1. Drilling and Anchoring Dowels
   a. Dowel layout template (made from 2x4's and plywood)
   b. Standard layout tools – tape, spray paint, markers, etc.
   c. Gang Drill (four drills) for dowel holes with adequate compressed air. Bits of correct size for dowel diameter. Check epoxy installation instructions for size.
   d. Gun for dowel epoxy injection. Air or battery-powered required for production jobs
2. Super-Grading
   a. 3' aluminum asphalt lutes or landscape rake for fine tuning the stone dust, square- and round-point shovels, heavy-duty garden rakes, vibratory compactor, water source/system for moistening stone dust
   b. **H.O.G. (supplied by Fort Miller)** and gas to run it. 2 Nylon lifting straps.
   c. Rails, Pin Straight Edge with shims (supplied by Fort Miller for setting rails)
   d. HOG Rail gage (2x4 notched at correct location for wheelbase of HOG)
   e. 10' magnesium straight edge for checking subgrade surface
   f. **Depth gage (supplied by Fort Miller)** for checking subgrade surface
   g. **Laser Slope Meter**
3. Setting Slabs
   a. Crane and rigging for setting slabs. Rigging must be long enough for chain/sling angle to exceed 60 degrees. Crane of adequate capacity. Provide means of adjusting sling length so that slabs hang at approximate design cross-slope, ie, chains or extra shackles.
   b. 2 tie off ropes, (4) 1 ¼" bars, approximately 4' long to be used for guiding slab into position. Wrenches for tightening lifting brackets.
   c. 4" X 4" high density plastic shims
   d. Bond breaker (form oil or DOT-approved equal in sprayer) to be applied to edges of slabs and dowels as required
4. Grouting (Equipment should be mounted on trucks and trailers for grout crew)
   a. Group pump/mixer of adequate capacity for mixing and pumping grout
   b. 1" grout hose with appropriate connectors and fittings, approx. 25' long, and one spare hose. (Two additional sections required for bedding grout with volumetric pumps)
   c. Grout nozzle to fit grout hose (first nozzle will be supplied by Fort Miller – 1" pipe thread)
   d. Batch-type pumps: Graduated plastic water pails for measuring grout water (available in paint dept. of local hardware stores) and 6 EA (min.) five-gallon pails for measuring
   e. Thermometer (infra red preferred) to measure grout water and powder temperature. Heating system for mix water and slabs if cold weather work.
   f. Great Stuff foam for grout dams at edge of slab and gloves for workmen
   g. Pointing trowels, squeegees, brooms, and several five-gallon pails
   h. ASTM C939 ½" diameter flow cone to check flow rate
   i. Grout testing equipment as required by Specification and/or Agency
   j. **Funnels for providing head to ensure dispersal of bedding grout**
   k. Water system of adequate capacity and pressure, min. of 2 spigots. VERY IMPORTANT!
   l. 50-gallon drums, or tub, for holding grout washwater
   m. Adequate supply of cones to block construction traffic off grouted slabs during curing